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The Effects of Military Advertising: Evidence from the Advertising Mix Test

James N. Dertouzos

March 1989

RAND

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Advertising is one of the central recruiting tools used by the military services in support of the all-volunteer force. This Note analyzes the effects of advertising on recruiting, providing quantitative estimates of the relative effectiveness of Army, Navy, Air Force, Marine Corps, and joint advertising programs. The findings indicate that, in general, the services gain enlistments from additional advertising, and the gains of any one branch do not seem to come at the expense (in terms of lost recruits) of any other. Not only are there no important interservice competitive effects of advertising, but the advertising done by a service apparently confers important benefits on the other branches as well. Consequently, both service and joint advertising appear to be powerful tools to help meet the recruiting requirements of the all-volunteer armed forces.

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PREFACE

This Note analyzes the effects of advertising on recruiting. The study provides quantitative estimates of the relative effectiveness of Army, Navy, Air Force, Marine Corps, and joint advertising programs. The research should be of interest to policymakers wishing to make decisions concerning the appropriate level and mix of advertising dollars.

The research was sponsored by the Office of the Assistant Secretary of Defense for Force Management and Personnel and is part of a larger project on the cost effectiveness of recruiting resources. The Note was prepared within RAND's Defense Manpower Research Center, under the auspices of the National Defense Research Institute, an OSD-sponsored Federally Funded Research and Development Center.

SUMMARY

Advertising is one of the central recruiting tools used by the services in support of the all-volunteer force. During the 1980s, annual expenditures have averaged about $80 million. Despite its importance, there is currently little information with which to resolve controversies about the appropriate level and allocation of advertising dollars to individual service and joint programs.

A review of recent research suggests that Army advertising is a very effective means of increasing the flow of enlistments into that service. Although the effects were found to vary substantially by media type, the marginal cost of recruiting an additional high-quality[1] person through advertising was about $6,000 during fiscal years 1982 and 1983. This compares favorably with other recruiting tools such as cash bonuses or adding to the recruiting staff.

Although the strong service-specific benefits of Army advertising is an important finding, it is not a sufficient basis for addressing the more general policy issues from a DoD perspective, because one cannot be sure if the expansion draws from the private sector or is increasing enlistments primarily at the expense of the other services. In addition, questions concerning the relative efficacy of the different service and joint advertising programs remained unanswered.

In response to the dearth of evidence on advertising, DoD supported the 1984 Advertising Mix Test (AMT), an ambitious field experiment designed to fill in some of the major knowledge gaps. Unfortunately, initial analysis based on observed enlistments during this period was inconclusive because of inadequate data, a failure to consider systematic differences between the services, and questionable judgment in the choice of methodologies. In particular, the exclusion of 60 percent of the control group, the use of annual instead of monthly information, and the emphasis on broad "test-cell" effects rather than actual fluctuations in advertising expenditures militated against finding statistically significant relationships. As a result, policy conclusions were not warranted.

Additional statistical analysis of information compiled during the AMT did shed new light on the advertising debate. Several new and important results emerged from the

[1]As defined by the Army, a high-quality male enlistee has a high school diploma and scores at the 50th percentile or above on the Armed Forces Qualification Test (AFQT).

estimation of enlistment models for all four services with monthly information on contracts, recruiters, quotas, market characteristics, and advertising expenditures. First, advertising programs appear to be very effective means of increasing the supply of enlistments to all four services. For aggregate enlistments, total service and joint programs have substantial expansion effects, which appear to favor the addition of more high-school graduates and individuals with strong AFQT scores. Although both categories have positive effects that are significantly different from zero, they are not distinguishable from each other in terms of cost effectiveness. An extra contract, regardless of service, can be induced for between $2000 and $3000 spent on either joint or service advertising. Without information about similar interservice effects, cost comparisons with other recruiting resources are difficult to make, but there is no apparent reason to cut the advertising budget.

Although aggregate enlistments may not be affected by shifts between joint and total service advertising, the individual branches would experience important differences. Ultimately, the preferred allocation between programs should be based on these considerations. For the Army, it is not possible to distinguish between the joint program and their own service program—they are both equally cost effective. For Navy advertising, imprecision in the estimate prevents any definitive conclusion. However, the joint program is very important to Navy recruiting. The predicted increase in Navy recruiting that would follow a shift of dollars from service to joint programs is significantly different from zero. In contrast, the service programs appear to benefit the Air Force and Marines more than does the joint program. The Air Force program appears to be very cost effective. Since the Air Force budget is primarily national magazine purchases, this result is consistent with previous research on Army magazine effectiveness. For Marine Corps contracts, effects of joint and their own service advertising are not statistically different from one another. However, evidence suggests that the Marine Corps program increases their flow of high-quality enlistments.

In general, the services appear to gain enlistments from additional advertising, and the gains of any one branch do not seem to come at the expense (in terms of lost recruits) of any other. More precisely, there are no important interservice competitive effects of advertising that are significant. In fact, the advertising done by a service apparently confers important benefits on the other branches as well. As a result, both service and joint advertising appear to be very powerful tools to help meet the recruiting

requirements of the all-volunteer armed forces. It is not possible to come to any unequivocal conclusions about the relative efficiency of joint versus service programs, and thus, there is no obvious reason to either cut the budget or reallocate funding.

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Nancy Vrotsos provided valuable programming support and managed the process of accumulating and refining the data files required for this project. This Note was much improved by Helen Turin's careful editing. Nora Wolverton, Paula Larich, Dolores Davis, and Pat Williams all made important contributions in the preparation of this manuscript.

Very thoughtful and valuable reviews were provided by Grace Carter, James Hosek, and Glenn Gotz. All remaining errors are my responsibility alone.

CONTENTS

TABLES

I. INTRODUCTION

During the 1980s, annual expenditures for recruiting advertising have totaled approximately $80 million. Separate budgets have been managed by each of the four services and by the Joint Recruiting Advertising Program. Even though most recruiting managers believe that advertising is a critical component of the marketing efforts in support of the all-volunteer force, this budget continues to be the focus of controversy. Despite yearly dialogues between representatives of the services, Office of the Secretary of Defense, and the Congress, no consensus has emerged. Debates about the absolute magnitude and the allocation of advertising dollars are likely to persist because there is very little information to either confirm or refute contentions about advertising effectiveness. The burden of proof has shifted to advocates of all recruiting programs, and the dearth of evidence favors those who wish to cut advertising.

Section II briefly summarizes the rather sparse literature on military advertising. An outline of major findings from a recent RAND study on the Army program is included. A recent analysis of the DoD Advertising Mix Test (AMT), an ambitious experiment designed to provide answers to questions about the absolute and relative merits of alternative service and joint programs, provides some evidence. Before ending with policy conclusions, this Note presents some new evidence based on a reanalysis of the AMT data in Sec. III.

II. A REVIEW OF ADVERTISING STUDIES

Ever since the the military draft was ended, numerous studies have analyzed the effects of recruiting resource options in attracting volunteers. Typically, authors have concluded that advertising is not as effective as alternative methods for attracting enlistments.[1] This conclusion is based on a failure to establish statistical relationships between enlistments and variations in levels of advertising expenditures. However, this absence of evidence is not convincing. The range of uncertainty suggested by the reported estimates often makes it impossible to conclude anything meaningful about advertising effects. Advertising research is frequently marred by weak data, abstract models that do not account for a complex range of potential phenomena, and econometric methodologies that do not consider the institutional and behavioral underpinnings that characterize the enlistment process.[2]

For example, it is well known that recruiters do not passively process enlistments. Rather, they allocate their own time in response to quotas and incentives to achieve and exceed them.[3] Recruiters may reduce effort in response to resource allocations or changes in economic conditions that increase the potential supply of enlistments.[4] Alternatively, even if categories of enlistments are in excess supply, it takes time to interview an applicant, process the enlistment, schedule examinations, and arrange interviews with job counselors. If recruiters produce changing numbers of low-quality contracts in response to goals, the number of high-quality enlistments will change even if other factors are held constant. Clearly, a model that does not control for these changes can yield misleading results.

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[1]Some examples include Bayus et al. (1985), Brown (1985), Goldberg (1982), Hanssens and Levien (1983), and Morey and McCann (1980).

[2]For a more detailed review of the literature and a discussion of some of the methodological challenges associated with the estimation of advertising effects, see Dertouzos and Polich (1989).

[3]See Dertouzos (1985, 1986) for further discussion.

[4]Previous statistical work suggests that recruiters, because they reduce effort, will typically enlist only about 70 percent of any potential market expansion. This suggests that increases in recruiting resources must be matched with increases in quotas if they are to be fully effective. See Polich, Dertouzos, and Press (1986).

THE EFFECTIVENESS OF ARMY ADVERTISING

A comprehensive data set describing monthly advertising expenditures between 1981 and 1984 for the Army provided a unique opportunity to circumvent some of the major problems plaguing advertising research. Detailed information on various media expenditures was collected and allocated to local market areas on the basis of actual audience or subscriber penetration. Accurate goal or mission data were also provided, thereby permitting the application of a model that accounted for the magnitude and direction of recruiter effort, local area market conditions, and levels of other marketing resources.

Estimates of this model provided some very strong results on the effectiveness of Army advertising. In particular, expenditures were found to be significantly correlated with short-run enlistment behavior. These effects were found to be persistent. A one-time change in Army advertising during a given month can induce increased enlistments for as long as six months. However, these effects diminish by a factor of 40 percent every month.[5]

The results also indicated that the effectiveness of the advertising budget depends on the media mix as well as the level of expenditures. Print media appeared to best promote enlistments.[6] National radio and television also appeared to be effective media choices. Local radio effects, however, were not significantly different from zero. For other categories of local advertising, no effects were detectable; but computed confidence intervals were very large, preventing any strong conclusions about their efficacy. Table 1 provides marginal cost estimates based on the results.[7] The point estimates range from a low of $1,980 for national magazines to $10,120 for national television. On average, one can compute an implied marginal cost of about $6,000 per high-quality recruit.

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[5]For example, if enlistments increased by 10 in the first month, they would increase by 6 in the second month, by 3.6 in the third month, and so on. This series of increases rapidly diminishes to about zero in the month 6. The total increase would be 24 enlistments, or 2.4 times the initial increase. These longer-term effects were estimated with a simple distributed (Koyck) lag structure for advertising. Standard transformations of the data were performed to purge correlations in the residuals.

[6]Models did not consider possible interaction effects among the media, nor did the data provide an opportunity to analyze major long-run changes in the advertising budget. Thus, the effectiveness conclusions should be viewed as reliable, but only in evaluating marginal changes in the level and distribution of the Army budget.

[7]The advertising data are described and coefficient estimates are provided in App. A.

Table 1

MARGINAL ADVERTISING COSTS: GSMA ARMY ENLISTMENTS[a]

Medium	Marginal Cost	Implied Range of Marginal Costs[b]
Local advertising		
Daily newspapers	$ 3,380	$1,060–5,410
Weekly newspapers	$ 1,680	$720-uncertain
Local radio	uncertain	$8,470-uncertain
High school newspapers	uncertain	$1,030-uncertain
National advertising		
Network radio	$ 7,280	$5,080–12,850
Television	$10,120	$7,345–16,270
Magazine	$ 1,980	$1,290–4,200

[a]GSMA enlistments are high-school graduates and senior males who score at the 50th percentile or above on the AFQT.

[b]Range of marginal costs corresponding to plus or minus two standard deviations from the estimated parameters.

This analysis of Army recruiting suggests that the immediate expansion effects stemming from increased advertising expenditures can be quite impressive. From the point of view of a recruiting manager primarily concerned with the short-term flow of Army enlistments, this evidence may be sufficient justification for strong support of the service programs. However, this view may be somewhat myopic. Appropriate criteria for comparing recruiting resource effectiveness are much broader.[8]

From a DoD perspective, establishing that a recruiting program effectively fulfills manpower requirements for an individual service is not sufficient. This is especially true if one views the competition as a zero-sum game in which expansions of enlistments come primarily at the expense of other services.[9] Alternatively, if the services compete primarily with the private sector rather than each other, such cross-branch considerations are not relevant.

[8]Even comparisons of expansion effects may be very difficult. In practice, recruiting resources will probably interact to produce their ultimate outcomes. This may be especially true of advertising. After all, other recruiting incentives are not going to influence enlistment decisions if potential recruits do not hear about them.

[9]Other important considerations not addressed here include the different skill channeling and term of service choices made by enlistees attracted by alternative programs.

Although the results on Army advertising may justify the program given that service's objectives, its efficacy is in terms of drawing enlistments away from civilian occupations and not from the other services. This distinction between service-specific and joint effects is crucial to the debate about advertising and for the evaluation of other recruiting programs as well.

THE DOD ADVERTISING MIX TEST

Responding to internal and legislative pressure to justify the prevailing level and allocation of advertising dollars, DoD sponsored an ambitious field experiment in 1984.[10] Areas of Dominant Influence (ADIs) were assigned to four different test cells on the basis of location and several additional factors including population, unemployment rates, and past enlistment propensities.[11] Advertising expenditures were varied systematically from cell to cell. Table 2 illustrates the basic design. Advertising expenditures for ADIs within the control group, representing 76 percent of the nation's male population between 17 and 21 years old, were held at a 1982 baseline level equivalent to an aggregate budget of $68 million for service and $16 million for joint advertising. For the three other groups of ADIs, each amounting to about 8 percent of the population, expenditures were dramatically altered. Planned service advertising was to fall by over 75 percent during fiscal year 1984 in the "low-service" cell. For other ADIs located in the "low-joint" area, joint advertising was reduced from a rate equivalent to the 1982 aggregate level of $16 million to $4 million. For this cell, service budgets remained at the previous level. Finally, the remaining ADIs were provided with lower

Table 2

ADVERTISING MIX TEST CELL DESIGN

Media Budget (Million $)	Control Cell	Low-Service Cell	Low-Joint Cell	High Joint/ Low Service
Service total	68	15	68	15
Joint total	16	16	4	40

[10]The experiment and its implementation are thoroughly described in Carroll (1987).

[11]ADIs are geographic areas constructed so that each county in the United States is assigned exclusively to the market whose local television stations dominate viewing in that county.

service budgets but with increased joint expenditures. Still, total advertising volume was to decline by 35 percent.

Given these rather dramatic and systematic variations in both service and joint advertising expenditures, the Advertising Mix Test (AMT) provided an unprecedented opportunity to provide much-needed answers to recruiting resource management questions. Based on econometric analysis of test-cell differences in enlistment outcomes, Carroll (1987) assessed the overall effectiveness of advertising, the relative efficacy of joint versus service, and the importance of a subset of interactive effects.[12]

Although the analysis had several components, the basic methodology and character of the most important empirical results are illustrated in Table 3. The logarithm of total FY 84 male high school graduate contracts (divided by the population 17 to 21 years old) and summed for all four services was regressed on the log of total recruiters (per population), the log of the unemployment rate, and variables taking on the value of one for ADIs located in the respective test cells (zero otherwise). The units of observation were yearly totals for 72 ADIs. This sample excludes 60 percent of the original control group. Apparently, these ADIs were eliminated because of failures to achieve 1982 benchmark levels of spending because of unexpected budget cuts. In Table 3, the Carroll results are reported and replicated by an independent analysis of similar models and data.[13]

Enlistments in the low-service budget ADIs, after some other factors are controlled for, are estimated to be higher by about 9 percent, on average. In comparison with the control cell representing base-line expenditures, the ADIs having lower joint budgets had lower enlistment rates. However, neither of these estimates is judged to be significantly different from zero or from each other at even the 90 percent level of confidence. Enlistments in the high-joint/low-service cells were estimated to be .3 percent lower. Again, this estimate is not significantly different from zero.

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[12]Clearly, a more comprehensive set of alternatives would have included cells experiencing a simultaneous expansion and/or contraction of advertising budgets. However, a desire to maintain the overall integrity of the advertising programs as well as other political, administrative, and budgetary considerations militated against a more complex design.

[13]The regressions models reported in Carroll (1987) also included measures of urbanization and the racial composition index for the ADI. Exclusion of these measures made almost no difference in the estimates. This is fortunate, because difficulties in acquiring the complete data set actually utilized by Wharton researchers prevented an exact replication of empirical estimates.

Table 3

ILLUSTRATION AND REPLICATION OF AMT RESULTS FOR MALE HIGH SCHOOL GRADUATE ENLISTMENT RATES

Independent Variable	Carroll Analysis	RAND Replication
Intercept	−.03	−.01
Log(recruiters)	.68*	.73*
Log(unemployment)	.27*	.20*
Test cells:		
Low service	.09	.09
Low joint	−.09	−.05
High joint/ Low service	−.003	−.003
R^2	.57	.57

Dependent Variable: The log of male high school graduate contracts.
*Significant at the 5 percent level.

Such empirical results are used in the Carroll study to support some very strong policy conclusions. Although more complicated analyses are performed, the essence of the argument is as follows: Predicted changes in enlistments are not significantly different from zero. In the case of service advertising, decreases may even promote higher enlistment rates. For the cell in which advertising dollars were shifted from service to joint budgets, the effect is not significantly different from zero. Finally, a comparison of estimates for the low-joint and low-service cells provides weak support of the notion that it might be better to cut the service budget.[14] Carroll concludes that overall spending should be cut, with the declines coming out of the service budgets. In the executive summary, he writes: "The empirical findings of the field experiment suggest that the Department of Defense can reduce its total advertising spending without adversely affecting recruiting performance." Continuing, he states: "The size of the Joint advertising budget should be increased as Service-specific budgets are scaled back."

[14]In the Carroll study, these pairwise comparisons were made on the basis of regressions using only observations from the two cells. Significant differences between cells did not hold up in the analyses of the larger sample of 72 ADIs.

Even if one accepts the empirical estimates as being unbiased, reliable, and derived through sound methodologies, the strong policy conclusions are not justified, given the imprecision of the reported estimates. Results that are insignificantly different from zero are not very useful if they are also indistinguishable from other meaningful values. This point can be illustrated if one computes the range of effects consistent with the 95 percent confidence intervals implied by the Carroll estimates. These intervals are reported in Table 4.

All three of the reported confidence intervals, derived from the standard errors and point estimates for the cell effects, include the value zero. For the low-service ADIs, the estimates imply that one can be 95 percent certain that the "true" value for the effect is within the range of of –8 to 27 percent. Given statistical conventions, one can not reject the possibility that the effect is zero. For the same reasons, the estimated effect of .09 is not distinguishable from –.08. Similarly, the true effect of the low-joint and high-joint/low-service levels of spending could be as low as –.25 and .16 percent respectively.

Since there were 264,000 high school graduate male enlistments in 1984, the range estimated for the low-service cell means that the $53 million decline in service advertising could lead to a 21,100 decline in enlistments (.08 × 264,000). This is equivalent to $2,512 per graduate. However, it is possible that enlistments could expand by 71,300. Not only would $53 million in advertising be saved, but it would be possible to save other resources as well.[15] For the low-joint cell, the lower bound estimate of a 25 percent fall in enlistments suggests that for each contract lost, the per contract savings in joint advertising dollars would only be $181. For the high/low cell, the 16 percent change implies a savings of $960 in advertising for each contract lost. These are very low numbers in comparison with the bonuses and educational benefits that the services are willing to pay recruits for joining. Advertising might well be very cost effective.

For all three cells, the per enlistment costs computed by using the lower bound of a 95 percent confidence interval are consistent with the hypothesis that advertising is a very effective recruiting resource. But the evidence is also consistent with the hypothesis that large sums of money could be saved by simply cutting advertising budgets. Thus,

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[15]For example, previous research suggests that increases in bonuses or pay can induce higher enlistments for $16,000 per additional Army high-quality recruit. See Polich, Dertouzos, and Press (1986). If a $53 million dollar cut in advertising really induced 71,300 more individuals to enlist, it would be possible to cut bonuses and/or pay by over $1.1 billion and still attract the original number of enlistments.

Table 4

RANGE OF EXPANSION EFFECTS IMPLIED BY AMT ESTIMATES

	Low Service	Low Joint	High Joint/ Low Joint
Change in $AD	–53 million	–12 million	–41 million
Range of test cell effects[a]	–.08 to .27	–.25 to .15	–.16 to .16
Range of changes in contracts (000)	–21.1 to 71.3	–66.0 to 39.6	–42.7 to 42.7
Range of cost per contract	$2,512 to ?	$181 to ?	$960 to ?

[a]The range was computed as the 95 percent confidence interval implied by the standard errors of the estimated test cell effect.

although the estimated advertising effects are not significantly different from zero, they are not different from a wide range of possibilities. In short, strong policy recommendations are not warranted.

Was the AMT capable of providing better evidence? For a variety of reasons, additional analysis of the data from this period is desirable. Previous analysis of these data was hampered by several problems that would have diminished the chances of coming to reliable conclusions.[16] These problems include the use of only 72 observations on combined annual recruiting outcomes (instead of monthly service-specific observations totalling over 2,500 independent observations), the failure to take advantage of significant within-cell variations over time and across ADIs in actual advertising dollars, the absence of any controls for significant and systematic differences in the allocation of dollars to alternative media choices, and the use of models that did not control for demand-side factors such as recruiting missions. In addition, there is strong evidence that use of a restricted control group for the experimental design of the test may have biased the results. For example, evidence in App. B suggests that the low-joint cell ADIs produced fewer enlistments than the control cell in 1983, before the AMT began. These test-cell differences were strong and persistent, even when controls for the actual levels of advertising were included in the analysis, suggesting that the models used in the analysis led to systematically biased and misleading results.

[16]We more fully document some of these difficulties in App. B.

III. NEW EMPIRICAL RESULTS FROM THE AD MIX EXPERIMENT

New empirical evidence on the cost effectiveness of military advertising is based on additional econometric analysis of observed monthly enlistment outcomes, advertising patterns, missions, demographic conditions, and recruiter allocations for all four services during FY 1984, the year of the Advertising Mix Test. As a result of this examination, several strong and provocative empirical relationships have emerged. These results are generally plausible and robust with respect to alternative methodologies and model specifications. But first, several important caveats are in order.

A NOTE OF CAUTION

The estimates of advertising effects presented here are as reliable as feasible, given reasonable contraints on time and resources available to study this complex issue. To be sure, these results narrow the uncertainty about advertising and should alter the perceptions of policymakers about the relative likelihood of outcomes resulting from changes in service and joint ad budgets. Still, this work does not provide unequivocal answers. It also has important limitations that should be closely scrutinized by other researchers in the future.

Data Deficiencies

The analysis was confined to data provided by the Wharton Center for Applied Research. Only 12 months of data were available with all the requisite goal and advertising information. Detailed information on market demographics were not available, nor were data on separate recruiting goals for different quality enlistments (except for the Army). In addition, there was no information on local advertising expenditures.[1] But, given the experimental design of the test, absence of this information is less likely to cause difficulties in the estimation of advertising effects than in usual

[1]Earlier RAND work on Army advertising strongly indicated that some types of local purchases, particularly newspapers, can increase enlistments. However, estimates for other categories did not change when local advertising was excluded from the model. Of course, local advertising is more important (at least in terms of volume) for the other services. So it is unclear how the absence of these data might bias the results.

circumstances. Indeed, evidence will be presented that qualitative results for measures of advertising are fairly insensitive to the inclusion and exclusion of other variables.

Serious attempts were made to verify the accuracy of the information that was made available. With some exceptions, the data were in reasonable but not excellent condition. Air Force and Marine Corps recruiting mission data initially received were not usable. Data oddities included monthly quotas of several thousand enlistments for a single ADI market and negative missions for some Marine Corps recruiters. Similar though less pronounced difficulties plagued other variables necessary for the analysis. It was possible to construct alternative data for the most apparent cases of measurement error, but inaccuracies undoubtedly remain.[2]

Model Simplicity

The estimating models were constrained by the availability of data. Previous work has demonstrated that models explicitly accounting for recruiter responses to their missions are better able to isolate the effects of environmental and resource influences, including advertising. The application of this approach to a model of all four services requires detailed information on the composition and the volume of recruiter missions, which is absent from our data.[3]

The models employed in this study examine the total number of contracts that result from the simultaneous interaction of supply and demand factors. Variables that influence individuals to supply enlistments include economic conditions, numbers of recruiters, and advertising expenditures. Demand factors include the recruiting quotas that affect both the magnitude and direction of recruiter effort. Even though the data do not permit the separate identification of these effects, the variables that are included do control for both factors. The estimated elasticities represent the total effect of supply factors on contracts when recruiting managers do not alter missions in the face of changing resource or economic conditions. This means that the importance of pure

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[2]This is not altogether surprising. The transfer of data often involved several steps (advertising rating agency to the services to Wharton to the Defense Manpower Data Center to RAND), with several chances to err along the way.

[3]Formally, identification of separate expressions for enlistment supply, total recruiter effort, and the allocation of that effort between different categories of enlistments requires at least two instruments (that is, factors that influence recruiter behavior but are unrelated to enlistment supply). For technical details, see Polich, Dertouzos, and Press (1986) or Dertouzos and Polich (1989). Without data describing higher quality missions, the full structure of such a model cannot be estimated.

supply factors on the potential expansion (with the institution of appropriate incentives) could be underestimated by the techniques used in this study.

Econometric Limitations

Brown (1985) argues that econometric analyses of enlistment supply should control for stable structural differences across geographic units. However, efforts to estimate fixed effects models were not successful in this study. No variables were significant. This lack of precision seems due to the short time series and the fact that the experimental design imposed systematic cross-section correlations in the data. That is, advertising allocations were dramatically changed in test cells for the duration of the sample period.[4] However, since the test design was statistically balanced, fixed differences between ADIs are much less likely to be correlated with other dependent variables, including advertising. Indeed, the inclusion of fixed effects for test-cell ADI groups did not measurably change the empirical estimates for advertising effectiveness (see App. C, Table C.2). Thus, the basic results on advertising should not be much affected.

EMPIRICAL RESULTS: EFFECTIVENESS OF ADVERTISING

In the following analyses, monthly enlistment rates in individual ADIs during 1984 are examined. For each of 210 markets, 12 months of data were utilized, resulting in 2,520 observations. For each of the four branches, the basic model assumes that total service-specific enlistment rates (contracts per 17–21 year old) will be a log-linear function of that service's recruiters and quotas per capita.[5] For example, the Army

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[4]This problem could be circumvented by modeling year-to-year changes, thereby netting out constant cross-section influences while maintaining the integrity of the experimental design. See Polich, Dertouzos, and Press (1986). Unfortunately, complete data were not available for the base-line year, so it was not possible to transform the data. Besides, given the data inaccuracies outlined earlier, differencing would increase the relative importance of measurement error in total sample variance, thereby introducing even more serious biases of another sort.

[5]These data were provided by the Wharton Center for Applied Research and are described more fully in Tables B.1-B.3 of App. B. The statistical model allows for contemporaneous correlation in errors across services ("seemingly unrelated" regressions) and also first-order autocorrelation (see Table C.1 in App. C). The coefficient of serial correlation, ρ, was estimated to be about .36, on average in the time-series. These complexities had little effect on the efficiency of the estimations nor did they significantly change coefficient estimates.

enlistment rate will depend on the number of Army recruiters and the quotas these recruiters are given. In addition, information on per capita income, unemployment rates, and ADI population (17–21 year old) was included.

The basic model also assumes that enlistment rates for each service are a log-linear function of their own national advertising expenditures as well as that of the other three branches. National advertising dollars were expressed as a weighted sum of current and past expenditures under the assumption that the effects diminish by 40 percent monthly.[6] Qualitative results are not sensitive with respect to alternative structures (see App. Table C.3). The statistical model allows for contemporaneous correlation in errors across services ("seemingly unrelated" regressions) and also first-order autocorrelation (see Table C.1 in App. C). The coefficient of serial correlation, ρ, was estimated to be about .36, on average in the time-series. These complexities had little effect on the efficiency of the estimations nor did they significantly change coefficient estimates.

Estimated elasticities are reported in Table 5. Models for all four services produced reasonable results, though explanatory power for the Army was greater.[7] The value of coefficients representing the effect of market conditions have signs that are consistent with earlier research. Enlistment rates in all four services rise with unemployment measures, decline with per capita income levels, and are higher in the

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[6]This assumption is consistent with direct estimates of the lagged effects of advertising reported in Dertouzos and Polich (1989) and described in Sec. II. Initial attempts to reestimate the lag structure for the Army were successful but very costly. Appropriate estimation methodology requires two lag tranformations (one to reduce the number of advertising terms and another to purge the first-order moving average structure that is imposed by the initial transformation. The resulting expression is highly nonlinear in the parameters and expensive to estimate. The estimated ρ for the Army was .58, suggesting that this assumption is reasonable. Although it would have been preferable to estimate unconstrained models for all four services, we decided that the minor gains from very significant increases in model complexity were not worth the cost.

[7]Attempts to verify data suggested that information describing the Army was more accurate than for the other services, possibly accounting for these differences. Also, previous research has directed more attention on Army relationships. Thus, understanding of the Army recruiting process is more accurate; and many of the assumptions, both stated and implied, by the models and methodology employed for all services are surely more accurate for the Army. Thus, Army results are probably more reliable.

larger ADIs.[8] Missions have a positive and significant effect on enlistments in all services. The value for the Army, .281, is similar to estimates derived elsewhere and suggests that recruiters increase effort when their quotas rise relative to potential enlistments.[9] The relative values for the quota elasticity suggest that Air Force recruiters are most responsive to their missions, and Navy recruiters are much less so. This is consistent with the evidence that the Air Force has had less difficulty attracting recruits than the Navy.

For the measures of national advertising effects, several significant coefficients were obtained. Joint advertising is estimated to have a positive effect for all four services, although the result for the Air Force[10] is not significantly different from zero. Service advertising for the Army and Air Force also appear to have significant positive effects. The estimates of own-service effects (the effect of a service's advertising expenditures on its own enlistments) are not significant for the Navy or Marine Corps. A review of the coefficients representing cross-service effects provides a mixed impression. However, the overall tendency (more on this later) of individual cross effects suggests that service advertising can expand the market for more than one service. Army advertising appears to help the Navy and the Marine Corps. Air Force campaigns may have a positive effect on the Marines and, to a lesser extent, the Army. The estimated elasticity of Navy enlistments with respect to Marine Corps advertising, however, is negative and significant.

The individual coefficients indicate percentage changes in total contracts resulting from percentage changes in advertising budgets. Thus, comparisons of different categories for a particular service or across equations are misleading unless they are weighted by the size of the relevant budget and the size of the contract base. For example, the .028 elasticity of Army contracts with respect to Army advertising implies that a 100 percent increase in the advertising budget will, for an average ADI with 57

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[8]ADI population is probably a proxy for other market characteristics such as urbanization, education levels, or racial and/or ethnic composition. The positive coefficient could also reflect scale economies in the productivity of recruiters.

[9]See Polich, Dertouzos, and Press (1986). The coefficient on the quota can be interpreted as the elasticity of an effort index (defined by the ratio of actual to potential enlistments) with respect to the production ratio (defined by the ratio of actual enlistments to quotas).

[10]Air Force advertising totals include prior service as well as non-prior service media purchases. This aggregation improved the precision of the Air Force estimates but made no difference for the other services.

Table 5

ANALYSIS OF SERVICE ENLISTMENT RATES: TOTAL CONTRACTS, BY SERVICE

Variable	Army	Navy	Air Force	Marine Corps
Intercept	1.583*	−1.277*	1.219	.053*
	(.561)	(.658)	(.779)	(.945)
Population	.015*	.060*	.029	.072*
	(.005)	(.011)	(.016)	(.016)
Unemployment	.649*	.220	.553*	1.629*
	(.198)	(.238)	(.280)	(.326)
Per capita Income	−.346*	−.063	−.315*	−.252
	(.084)	(.098)	(.117)	(.139)
Recruiters	.227*	.526*	.303*	.470*
	(.051)	(.055)	(.071)	(.075)
Quota	.281*	.119*	.465*	.215*
	(.041)	(.026)	(.061)	(.049)
Advertising:				
Joint	.016*	.028*	.008	.023*
	(.006)	(.008)	(.009)	(.011)
Army	.028*	.032*	.009	.024
	(.008)	(.010)	(.011)	(.013)
Navy	−.008	−.005	.014	.004
	(.008)	(.009)	(.011)	(.013)
Air Force	.014	.000	.071*	.075*
	(.012)	(.014)	(.017)	(.020)
Marine Corps	−.007	−.011*	−.001	.009
	(.004)	(.005)	(.006)	(.008)
R^2	.393	.212	.258	.245

*Significant at 5 percent.

Army contracts, expand the market by 1.6 contracts (.028 × 57). In contrast, the same increase in Army advertising will induce a .032 percent increase in Navy enlistments as well. Despite the higher elasticity, the actual expansion for the Navy is only 1.2 contracts (.032 × 38). In addition, comparisons of advertising effectiveness must also consider the size of the budget base. For example, a 100 percent increase in the Army

budget for a typical ADI amounts to over $11,000, whereas doubling the joint budget costs only half as much, $5,500. Thus, the expansion in enlistments due to equivalent percentage increases would have to be twice as large for one to conclude that Army advertising is more cost effective.

To make relevant comparisons more apparent, marginal cost estimates were computed. Table 6 provides estimates of the extra cost in joint, Army, total service, and total advertising dollars required to add an additional Army, Navy, Air Force, or Marine Corps contract. The last column provides the marginal advertising cost of a single contract, regardless of service, attained by expanding all advertising proportionately.

These estimates suggest that advertising can be a very effective means of increasing enlistments. For example, obtaining an additional Army contract can cost as little as $6,400 by expanding joint advertising. The equivalent cost through Army advertising is $7,014. These cost differences are based on expansion effects that are not significantly different from each other. Expansions of the joint budget are very cost effective for producing Navy enlistments. Service advertising is very effective for Air Force enlistments. For the Marines, even though estimates of the effectiveness of its own program are too imprecise to draw conclusions, the total advertising budget for the services has a significant and positive effect.

These estimates are not perfectly comparable to the estimates of marginal costs presented earlier because those were for GSMA enlistments, not total contracts. However, rough calculations suggest that they are likely to be quite close. For example, we can assume that when total enlistments expand, all categories of enlistments will change proportionately. Also, by applying previous empirical estimates of the relative cost of high- and low-quality enlistments[11] we can estimate the potential increase in high quality that occurs when total enlistments change. For example, about 40 percent of all Army enlistments were GSMA in 1984. Assuming a tradeoff rate between high quality and other enlistments of 3/1, a given expansion effect could potentially (with appropriate recruiter incentives) increase high-quality enlistments by .6 (.4 + 1/3(.6)). For the other services, the same calculation ranges from .63 to .73 (see App. Table C.5 for details).

These conversion rates are underestimated if marginal changes in enlistments favor high-quality individuals. Estimates of empirical expansion paths (see App. Table C.6) based on year-to-year changes in enlistments suggest a conversion rate of between

[11]Dertouzos (1985) and Polich, Dertouzos, and Press (1986) estimate that the feasible tradeoff between categories is about one high-quality recruit for every three lower quality enlistments.

.78 and .94 for marginal changes. Again, assuming that recruiting managers can induce substitution across categories yields a result that marginal cost estimates for total contracts are between 85 and 96 percent of measures for high quality.

Although estimates of the effectiveness of many categories are significantly different from zero, wide standard errors on the estimates for others make some comparisons across categories very difficult. For example, even though service advertising does not have an expansion effect that is significantly different from zero for either the Navy or Marine Corps, the lower bound estimate of marginal costs based on a 95 percent confidence interval suggest that these programs could be quite effective. For example, it could cost as little as $3,094 to add a Navy enlistment by increasing service advertising. For Marine Corps advertising, the comparable lower bound implied by a standard confidence interval is $3,964.[12] Some of the more interesting hypotheses are described in Table 7.[13]

Even though both Army and joint programs have substantial expansion effects on total and Army enlistments, they are not significantly different from one another (per

Table 6

MARGINAL COSTS OF AN ENLISTMENT: POINT ESTIMATE PER CONTRACT

Advertising Dollars	Army	Navy	Air Force	Marine Corps	All
Joint	6,414*	5,014*	23,983	13,454	2,122*
Army	7,014*	9,090*	47,345	26,425	3,210*
Service (total)	10,439	26,620	6,338*	7,067*	2,456*
All	8,991*	12,640*	7,814*	8,048*	2,260*

*Based on contract expansion effects that were significant at the 5 percent level.

[12]Appendix Table C.4 reports lower-bound estimates for comparison with the point estimates of Table 6.

[13]These comparisons are based on linear restrictions on estimated coefficients. For example, the evaluation of Army versus joint advertising in the production of total contracts was based on an F-Test comparing the mean squared error (MSE) for a freely estimated model with the MSE obtained by imposing the restriction that the per dollar expansions in total contracts were the same for two programs. Per dollar expansions were expressed as a linear combination of advertising elasticities. The coefficients were weighted by advertising budgets (and enlistment shares for multi-service comparisons) for per-dollar comparability.

Table 7

SIGNIFICANCE OF COST EFFECTIVENESS COMPARISONS: JOINT HYPOTHESIS TESTS

Contracts	Comparison Category	F-Test of Significance[a]
Total	Army vs. joint	No difference
	Total service vs. joint	No difference
Army	Army vs. joint	No difference
	Total service vs. joint	No difference
Navy	Navy vs. joint	No difference
	Total service vs. joint	Joint higher
Air Force	Air Force vs. joint	Air Force higher
	Total service vs. joint	Total service higher
Marine Corps	Marine Corps vs. joint	No difference
	Total service vs. joint	No difference

[a]Significant at 5%.

dollar). Both estimates are very accurate and significantly different from zero, but they are very close to one another. For Navy contracts, a comparison of joint and service advertising clearly rejects the hypothesis that these categories are indistinguishable. Joint advertising is very important to the Navy. However, the estimates for the effect of Navy advertising are not accurate enough to make direct comparisons of joint and Navy programs.[14]

For the Air Force, per-dollar effectiveness is significantly higher for their own program and for service advertising in general. They would be harmed by a shift of dollars to the joint program. For the production of Marine enlistments, no significant differences between service categories can be detected. This is not because advertising effects are insignificant, but rather, they are not different from one another.

To test for robustness of estimates, several versions of the models can be compared. In addition to the basic model described above, six further versions were estimated. A summary of the most important hypothesis tests is described in App. Table C.3. First, fixed effects were included for the different cell groups. There were

[14]If dollars were shifted from all the services (in proportion to their current allocation) and given to joint, the Navy would benefit. If the same total amount were shifted from the Navy budget, it is not certain that the Navy would be better off.

significant differences between geographic areas. However, probably because the initial test design was statistically balanced, these differences had no important effect on the results.

To account for other potential cross-service competitive effects, a version was estimated that included all service quotas and another that included quotas and all service recruiters in each equation. Besides yielding estimates of advertising effects that were consistent with the basic model, another striking conclusion emerged: A service's recruiting efforts contribute positive externalities to the other branches. For example, the aggregate effect of a service's missions on total contracts is positive and significantly greater than the effect on its own contracts alone. This result is consistent with the notion that each service's main competition is the civilian sector, not the other branches of the military.[15]

Although it was desirable to examine the possible expansion effects on different categories of enlistments, there was no information on recruiter incentives to change the direction of effort. Looking at single categories of enlistments without simultaneously controlling for changes in other categories can be quite misleading. However, separate regressions for three categories of enlistments can be compared for each of the four services. The results for these 12 regressions using the basic model are reported in Table 8. For high-, medium- (other graduates), and low-quality (nongraduates) contracts, the results were consistent with the relationships found between total advertising and contracts. For the graduate categories, service advertising appeared to be quite effective for increasing enlistments in all services. Joint advertising remained an important program for the Navy, although imprecision in the estimated effect of Navy advertising precluded any strong conclusions about their relative efficacy. For the Marines, their own program appeared to have an important effect on drawing high-quality recruits. This effect dominated the joint program in the production of high-quality Marine Corps recruits.

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[15]This result bears further analysis. It is possible that the correlations are spurious because of omitted variables that would tend to move enlistments (and quotas) for all services in the same direction.

Table 8

DECOMPOSING THE ENLISTMENT EFFECTS OF ADVERTISING: HYPOTHESIS TESTS FOR HIGH-, MEDIUM-, AND LOW-QUALITY RECRUITS

Advertising Effectiveness	F-Test for MSE Ratio with Restriction		
	High Quality I-IIIA Grads	Medium Quality Other Grads	Low Quality Non-Grads
Army contracts			
Army ads = 0	0	+++	+
Joint ads = 0	0	0	0
Service ads = 0	+++	+++	+
Army = joint	++	+++	0
Navy contracts			
Navy ads = 0	–	–	--
Joint ads = 0	+++	++	0
Service ads = 0	++	0	0
Navy = joint	0	---	0
Air Force contracts			
Air Force ads = 0	+++	+++	+
Joint ads = 0	++	0	0
Service ads = 0	+++	+++	0
Air Force = joint	++	+++	0
Marine contracts			
Marine ads = 0	+++	+	0
Joint ads = 0	0	0	0
Service ads = 0	+++	0	0
Marine Corps = joint	+++	0	0
Total contracts			
Joint = 0	+++	+	0
Army = 0	0	+++	0
Navy = 0	0	0	0
Air Force = 0	+++	++	+
Marine Corps = 0	0	++	0
Service ads = 0	+++	+++	0
Service ads = joint	+	+++	+

+++ (---) denotes significantly greater (lower) at 1%.
++ (--) denotes significantly greater (lower) at 5%.
+ (-) denotes significantly greater (lower) at 10%.

IV. CONCLUSIONS

This analysis of the AMT data has three broad conclusions: First, service and joint advertising both appear to be powerful tools to help meet the recruiting requirements of the active duty forces. Comparisons with other resource options will be difficult to make until their cross-service effects are evaluated. However, advertising appears to compare quite favorably with more expensive options such as cash bonuses or pay. Second, our results do not provide unequivocal conclusions about the relative efficacy of joint versus service programs. Both options have significant but statistically equivalent effects. There is no obvious reason to either cut the budget or reallocate funding. Finally, competition among the services does not diminish the usefulness of advertising from the DoD perspective. Service expansion effects typically do not come at the expense of other branches. The drawing power of an individual service's advertising program often benefits other services as well.

These conclusions do not imply that policymakers should be indifferent among advertising budget allocations because there are important differences among the services. Although Army enlistments are, per dollar, equally affected by joint and service expenditures, the Navy seems to rely more on the joint program while the Air Force and Marine Corps appear to benefit more from their own service budgets. To sustain each service's competitiveness, the differential consequences of changes in the advertising mix might have to be countered with a redistribution of other recruiting resources.

Despite limitations discussed in Sec. III, the empirical results appear quite robust with respect to alternative model specifications. In addition, estimates of advertising effectiveness for the Army program are remarkably similar to those obtained from earlier studies, even though the latter use different data, models of the underlying recruiting and advertising process, and statistical methodologies. These are powerful reasons to be optimistic about the results of this study despite data deficiencies and the concomitant econometric problems that could have affected the estimates.

Appendix A

EFFECTIVENESS OF ARMY ADVERTISING

This appendix describes the data and provides more detail on the underlying estimates used in the analysis of Army advertising discussed in Sec. II. Table A.1 provides data on advertising expenditures representing monthly observations from July 1981 through June 1984. Observations described advertising within each of 66 areas as defined by the boundaries of the Department of Defense Military Entrance Processing Stations (MEPS). DoD routinely collects many data items for these areas, which are defined along county lines. The pattern of expenditures for national advertising is identical to that observed for the Army during the year of the AMT.

Table A.2 provides sample means and standard deviations for enlistments and control variables included in the econometric analysis. Information on wages, unemployment rates, quotas, and recruiter numbers in a sample month are given.

Table A.1

MONTHLY ADVERTISING EXPENDITURES, ARMY MEPS AVERAGES, 1981–1984

Expenditures	MEPS Monthly Average	Percent
National		
Television	$16,597	69
Network radio	4,367	18
Magazine	3,069	13
Total National	$24,033	100
Local		
Local radio	$ 2,541	57
Daily newspapers	1,217	27
High school papers	369	8
Weekly newspapers	352	8
Total Local	$ 4,479	100

Table A.3 provides elasticity estimates for various advertising measures. The implied elasticity (the sum of coefficients weighted by the size of the budget) for national advertising is very close (.020) to the one reported in the analysis of Sec. IV.

Table A.2

ARMY ENLISTMENT AND MEPS MARKET DATA

Variable Name	Mean	Standard Deviation
High-quality contracts	71.0	49.3
Other contracts (male)	78.9	55.5
Unemployment rate (percent)	8.85	2.30
Civilian wage rate (hourly)	8.62	1.19
Number of recruiters	73.8	48.3
High-quality quota	64.0	44.5
Other male quota	72.5	48.8

NOTE: Based on 2376 monthly observations (66 MEPS areas, each measured during 36 months).

Table A.3

ECONOMETRIC RESULTS ON ARMY ADVERTISING

Variable	Coefficient	Standard Error	t
Local advertising			
Daily newspapers	.0051	.0021	2.38
Weekly newspapers	.0029	.0020	1.49
Local radio	.0000	.0021	0.00
High school newspapers	–.0011	.0026	–0.44
National advertising			
Network radio	.0085	.0018	4.65
Television	.0231	.0044	5.29
Magazine	.0218	.0058	3.80

Appendix B

THE ADVERTISING MIX DATA SET

This appendix provides additional information on the data compiled by the Wharton Center for Applied Research for use in analyzing the AMT. More detail is also presented on the evaluation of a previous analysis of the AMT found in Carroll (1987).

Table B.1 describes enlistment outcomes, by service, for the year of the AMT. These enlistment totals represent monthly ADI averages. In addition, the percent graduate-senior males I-IIIA (GSMA), the number of production recruiters, and the mean total contract mission for the different branches are given. Next, demographic market data are shown. Table B.2 outlines averages and ranges for ADI population, the unemployment rate, and per capita income.

Table B.3 describes advertising data. The average monthly expenditures for service and joint national advertising programs are expressed in per capita terms for the whole sample and for the test cells. Note that Army advertising is by far the largest

Table B.1

ENLISTMENT OUTCOMES: ADI AVERAGES FOR FY 1984

Variable	Army	Navy	Air Force	Marine Corps
Total contracts	57.1	38.7	26.9	15.7
Percent I-IIIA males	39	43	61	41
Production recruiters	31.0	27.2	8.8	14.3
Contract mission[a]	56.9	31.4[a]	23.4	14.1

[a]Male only.

Table B.2

DEMOGRAPHIC MARKET DATA: ADI AVERAGES FOR FY 1984

Variable	Mean	Range
ADI population (17–21)	100,861	2,854–1,519,147
Unemployment rate	.086	.028–.328
Per capita income	10,320	6,026–15,697

category.[1] The per capita variations observed are consistent with the planned design of the test. However, the Air Force totals, including non-prior service budgets, did not vary systematically across cells. Data problems made it impossible to separate categories for the Air Force.

The mix of media purchases is analyzed in Tables B.4 and B.5. Apparently there are significant differences between the different service and joint programs. On average, joint is primarily television, with 88 percent of the budget. The Army program

Table B.3

DOD ADVERTISING MIX DATA: ADI AVERAGES, FY 1984

	Monthly Average Dollars, All ADIs	Annual Per Capita Expenditures			
		All ADIs	Low Service	Low Joint	High/Low
Joint	$5,516	$.66	$.77	$.14	$2.07
Army	11,363	1.35	.44	1.51	.51
Navy	1,610	.19	.07	.25	.09
Air Force	1,335	.16	.15	.16	.15
Marine Corps	1,665	.20	.11	.24	.09

Table B.4

MEDIA ALLOCATION OF SERVICE AND JOINT AD DOLLARS

		Percent of Category Allocated			
Category	ADI Mean	TV	Radio	Magazines	Other
Joint	5,516	88	0	11	0
Army	11,363	66	13	14	7
Navy	1,609	0	54	30	16
Air Force	1,335[a]	0	0	92	8
Marine Corps	1,665	42	10	17	31
Total Ad $	21,448	61	11	20	8

[a]Includes expenditures on prior service advertising campaigns.

[1]The ADI monthly average of $11,363 represents an annual advertising total of about 29 million. This total does not include about $6 million in advertising directed towards those who have previously served (non-prior service). Data on local advertising were not available.

Table B.5

NATIONAL ADVERTISING ALLOCATIONS ACROSS MEDIA: DIFFERENCES ACROSS TEST CELLS
(Percent)

	All ADIs	Low Service	Low Joint	High/Low
Joint, TV	88	89	41	96
Army, TV	66	50	68	54
Army, radio	13	2	11	4
Army, magazine	14	39	14	34
Navy, radio	54	4	60	7
Air Force, magazine	92	91	92	92

emphasizes television, at 66 percent of their national budget, but spends 13 percent on radio; 14 percent on magazines; and 7 percent on newspaper, direct mail, and miscellaneous categories. The Navy emphasizes radio. National budgets were not high enough to support TV network programs in 1984.[2] Given the imprecision in the earlier Army study's local advertising estimate, one might expect difficulties in identifying a Navy effect. The Air Force spends much of its budget on national magazines. This category was found to be the most effective on the margin of all the Army purchases, at least in the range of budget allocations observed during 1981–1983. Table B.5 indicates that the experiment had dramatic effects in advertising allocations across cells. In particular, the advertising cuts appear to have come mostly at the expense of electronic media.

The allocation of national advertising dollars can also be described in regressions of advertising dollars on population and location (in the different test cells). These results (see Table B.6) highlight the very systematic and significant cross-section variation across geographic areas. In these results, the control subset denotes the ADIs of the original test cell that were retained in the Carroll analysis. The positive coefficient for joint advertising suggests that spending was almost 30 percent lower, on average, in ADIs excluded from the analysis.

Table B.7 reports results from a regression having the same form as the Carroll model but applied to monthly data for all four services. These regressions include those

[2]As we saw in App. A, the local Army program emphasizes radio, with some money going into daily, weekly, and high school newspapers.

ADIs in the final sample of 72. Only the coefficients on test cells are provided. Some heterogeneity persists, but patterns are similar across all services. The low joint cell appears to have contract rates that are significantly lower than the other cells. An F-test based on imposing the assumption that the low joint was not different can easily be rejected. It appears that joint is effective, while the results for the other cells do not permit similar conclusions. An identical regression for 1983 data is described in Table B.8. Again, the low-joint cell has enlistment rates that are significantly lower than in other parts of the nation. This means that the purported "advertising" effect occurred in the year before the experiment as well. In other words, the cell effect had little to do with changes in advertising. This "fixed effect" did not affect all services simultaneously. Instead, it seemed to be more pronounced for the Marine Corps.

Table B.6

EMPIRICAL ANALYSIS OF ADVERTISING ALLOCATIONS

	Army	Navy	Air Force	Marines	Joint
Intercept	−2.124*	−3.852*	−5.843*	−4.429*	−2.501*
	(.081)	(.141)	.240	(.085)	(.133)
Log(population)	1.028*	.986*	1.116*	1.048*	.998*
	(.007)	(.012)	(.021)	(.007)	(.012)
Low-service cell	−1.401*	−.752*	−.312*	.090*	.146*
	(.032)	(.056)	(.095)	(.033)	(.053)
Low-joint cell	−.074*	.152*	.139	.088*	−.806*
	(.036)	(.064)	(.117)	(.038)	(.060)
High joint/ low service	−1.304*	−.611	−.213*	−.094*	1.104*
	(.028)	(.050)	(.085)	(.030)	(.047)
Control subset	−.045*	.025	.117	.001	.291*
	(.022)	(.038)	(.065)	(.023)	(.036)
R^2	.919	.948	.827	.931	.947

NOTE: Standard deviations in parentheses.
*Significant at 5%.

Table B.7

ENLISTMENT CONTRACT RATES: FY 1984 TEST CELL EFFECTS

	Army	Navy	Air Force	Marine Corps	F-Test
Low service	.035	.013	.057	.013	2.120
	(.026)	(.039)	(.037)	(.041)	
Low joint	−.056*	−.064	−.136*	−.212*	16.126*
	(.029)	(.037)	(.042)	(.047)	
High joint/	−.028	.034	−.091*	−.065	2.285
low service	(.023)	(.029)	(.033)	(.036)	

NOTE: Standard deviations in parentheses.
*Significant at 5%.

Table B.8

ENLISTMENT CONTRACT RATES: FY 1983 TEST CELL EFFECTS

	Army	Navy	Air Force	Marine Corps	F-Test
Low service	.007	.006	−.002	−.086*	.096
	(.028)	(.033)	(.039)	(.042)	
Low joint	−.037	−.058	−.090*	−.103*	6.067*
	(.032)	(.037)	(.044)	(.048)	
High joint/	.030	.031	−.086*	−.007	.003
low service	(.024)	(.029)	(.033)	(.037)	

NOTE: Standard deviations in parentheses.
*Significant at 5%.

Appendix C

SUPPLEMENTAL ANALYSIS OF THE AD MIX EXPERIMENT DATA

This appendix provides additional information on the analysis reported in Sec. III. Table C.1 reports the estimates of the coefficient of first-order autocorrelation used in the transformations of the basic model. These estimates, based on regressing computed residuals on their lagged values, range from .270 for the Marine Corps to .449 for the Navy.

Table C.2 provides the coefficient estimates obtained from the basic model plus the addition of test-cell variables. Since advertising measures are simultaneously included in the models, there is no a priori reason to expect that these fixed effects would be significant. Three interesting results emerge. First, cell differences exist, even when controls for advertising are included. In addition, these fixed effects work in the opposite direction from the actual advertising effects. Therefore the test-cell effects do not represent advertising relationships. In fact, they tend to bias conclusions away from finding significant advertising effects. Finally, the qualitative nature of the advertising coefficient is not changed when such fixed effects are included, so within-cell variations in advertising expenditures are very important in explaining enlistment rates.

Table C.3 summarizes hypothesis tests based on the standard model and several other variations. Recall that the basic model allows for first-order serial correlation and accounts for contemporaneous correlations across equations. Advertising is expressed as the sum of current and past expenditures with effects depreciating at the rate of .6 monthly. Model 2 allows for fixed effects in the three test cells. Model 3 uses full

Table C.1

TESTS FOR AUTOCORRELATION

	Army	Navy	Air Force	Marine Corps
Estimate of ρ	.372*	.449*	.350*	.270*
	(.019)	(.019)	(.020)	(.020)

NOTE: Standard deviations in parentheses.
*Significant at 5%.

Table C.2

INDEPENDENT TEST-CELL EFFECTS ON ENLISTMENT RATES

Variable	Army	Navy	Air Force	Marine Corps
Intercept	2.272*	−.597	1.161	.860
	(.638)	(.697)	(.800)	(.972)
Population	.018*	.056*	.025	.059*
	(.008)	(.011)	(.017)	(.016)
Unemployment	.638*	.138	.429	1.602*
	(.198)	(.239)	(.281)	(.326)
Income	−.400*	−.111	−.285*	−.096
	(.085)	(.102)	(.122)	(.142)
Recruiters	.171*	.412*	.264*	.225*
	(.054)	(.063)	(.074)	(.080)
Mission	.320*	.145*	.245*	.128*
	(.047)	(.027)	(.104)	(.050)
Advertising				
Joint	.011	.021*	.006	.017
	(.008)	(.009)	(.011)	(.013)
Army	.056*	.072*	.009	−.002
	(.012)	(.015)	(.017)	(.020)
Navy	−.005	−.006	.014	−.002
	(.008)	(.010)	(.011)	(.013)
Air Force	.003	−.021	.051*	.048*
	(.012)	(.015)	(.017)	(.020)
Marine Corps	−.007	−.012*	.000	.011
	(.004)	(.006)	(.006)	(.007)
Fixed Effects				
Low service	.140*	.170*	.062	.047
	(.037)	(.047)	(.052)	(.061)
Low joint	−.009	.008	−.046	−.042
	(.032)	(.040)	(.011)	(.054)
High joint/ low service	.094*	.154*	−.008	.033
	(.035)	(.043)	(.050)	(.058)

NOTE: Standard deviations in parentheses.
*Significant at 5%.

reduced forms by including all service variables, recruiters, and missions in each equation; and Model 4 adds other service missions only. Model 5 does not allow for autocorrelation; finally, Model 6 measures advertising in current terms and does not consider the lagged effects.

The three entries for Army contracts indicate how significantly different from zero Army and joint ads are. Army ads are different at the 1 percent lev l and joint at the 5 percent level. The third test is whether service and joint ads are eq ally effective at producing Army enlistments. The 0 indicates they are not statistically different. For comparability, all coefficients are weighted to account for different enlistment levels and budget amounts. The last set of entries suggests that, for producing total contracts, Army, Air Force, and joint advertising appear to be very effective.

Table C.4 gives marginal costs of an enlistment for the implied lower bound of 95 percent confidence intervals taken from the standard model of contracts in all four services. That is, one could not reject the hypothesis that marginal costs were as low as these numbers. For all the categories, one cannot be sure that the costs are not fairly low, at least in comparison with such other recruiting alternatives as increased cash bonuses. This implies that all types of advertising are very effective, or at least that the opposite cannot be proven.

Table C.5 provides indexes for computing marginal costs per high-quality recruit from the costs estimated for total contracts. The first method assumes that a contract expansion will be in proportion to the current percentage of high-quality enlistments. For the Army, that number is .39. Now, assuming that the potential conversion of low-quality into high-quality recruits is 3 to 1, the .61 expansion in lower-quality recruits can be converted into 1/3 x .61 or .2 additional high-quality enlistments. Thus, the conversion index is .59. This means that an expansion of one contract can be converted into .59 high-quality enlistments for the Army.

Instead of assuming constant proportionality, one can observe the actual expansion paths during 1984. By regressing changes in the number of high-quality contracts on changes in total contracts, one can determine the appropriate conversion. This relationship for the Army indicated that when contracts change by one contract, high-quality enlistments also change by .94 contracts.[1] The conversion indexes implied by the empirical expansion paths actually observed suggest that marginal costs computed

[1]Regressions were for year-to-year changes in contracts during a given month.

Table C.3

HYPOTHESIS TESTS FOR ALTERNATIVE MODELS, ROBUSTNESS OF ADVERTISING COST EFFECTIVENESS

Advertising Effectiveness Restriction on	F-Test for MSE Ratio with Restriction					
	Model I	Model II	Model III	Model IV	Model V	Model VI
Army contracts						
Army ads = 0	+++	+++	0	+	+++	+++
Joint ads = 0	++	+++	+	++	+++	+++
Service = joint	0	0	0	0	0	0
Navy contracts						
Navy ads = 0	0	0	0	0	-	0
Joint ads = 0	+++	+++	+++	+++	+++	+++
Service = joint	---	0	---	--	---	---
Air Force contracts						
Air Force = 0	+++	+++	+++	+++	+++	+++
Joint ads = 0	0	0	0	0	0	0
Service = joint	+++	+++	+++	+++	+++	+++
Marine contracts						
Marine ads = 0	0	0	0	0	0	0
Joint = 0	+++	+++	0	+++	+++	+++
Service = joint	0	0	0	0	0	0
Total contracts						
Army = joint	0	0	0	0	0	-
Service = joint	0	0	0	0	0	++
Army ads = 0	+++	+++	++	+++	+++	+++
Navy ads = 0	0	0	0	0	0	0
Air Force = 0	+++	+++	+++	+++	+++	+++
Marines Corps = 0	-	0	0	0	0	-
Joint ads = 0	+++	+++	+++	+++	+++	+++

+++ (---) denotes significantly greater (lower) at 1%.
++ (--) denotes significantly greater (lower) at 5%.
+ (-) denotes significantly greater (lower) at 10%.

from regressions on total contracts are between 85 and 96 percent of the costs of attracting a high-quality enlistment.

Table C.4

MARGINAL COSTS OF AN ENLISTMENT: IMPLIED LOWER BOUND OF 95 PERCENT CONFIDENCE INTERVAL

Advertising Dollars	Army	Navy	Air Force	Marine Corps
Joint	3,448	3,264	7,661	6,727
Service (own)	4,527	3,094	468	3,964
Service (total)	2,189	3,014	2,291	3,905
All advertising	3,164	4,001	3,783	4,376

Table C.5

CONVERSION OF MARGINAL COSTS TO PER HIGH-QUALITY CONTRACT BASIS

	Army	Navy	Air Force	Marine Corps
I. Current fraction of I-IIIA grad males	.39	.44	.59	.44
Conversion index, holding non-I-IIIA constant[a]	.59	.63	.73	.63
II. Empirical expansion path	.94	.91	.94	.78
Conversion index, holding non-I-IIIA constant[a]	.95	.94	.96	.85

[a]Assumes 1 for 3 tradeoff of I-IIIA for other contracts.

Table C.6

EMPIRICAL EXPANSION PATHS: COMPARISONS OF HIGH-QUALITY AND TOTAL CONTRACTS

	Year-to-Year Change in I-IIIA Male Graduates			
	Army	Navy	Air Force	Marine Corps
Intercept	−.005	−.025*	.005	−.011
	(.008)	(.089)	(.008)	(.012)
Change in total contracts	.942*	.906*	.942*	.785*
	(.023)	(.022)	(.016)	(.021)
R^2	.405	.405	.583	.364

NOTE: Standard deviations in parentheses.
*Significant at 5%.

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